ARTICLE V.

FOSSIL MAMMALIA OF THE WHITE RIVER BEDS OF MONTANA.

BY EARL DOUGLASS.

(Read May 3, 1901.)

Since writing my paper on the Tertiary deposits of western Montana (1899)* further explorations have been made and many valuable fossils secured. Part of these fossils have been studied under more favorable circumstances, so that interesting additions can now be made to our knowledge of these beds.

In June, 1899, Prof. F. D. Smith, of the University of Montana, and myself started eastward from Missoula with team and camping outfit, he to collect geological specimens for the University and I to make further explorations in the Tertiary deposits, and to add, if possible, to my collection of fossil mammals. Nearly all of my previous collecting had been done east of the main divide or watershed of the Rocky Mountains. I had found that Tertiary deposits occurred in the valleys of Flint and Deer Lodge creeks, and it was hoped that enough fossils might be obtained to determine the horizons of these beds and their relation to those east of the divide.

In the valley of Flint creek, south of Drummond, near the village of New Chicago, the upper deposits were found to contain, in a limited area, quite an abundance of valuable Loup Fork fossils. The exact relation of these beds to those of other localities is still a matter of doubt. The strata and the occurrence of the fossils are almost exactly as in the upper Deep River beds. This is not true of any other deposits I have seen. The bones, as a rule, are in nodules in cream-colored clays. The species seem to be mostly new, but have not been thoroughly studied. Some of the most interesting specimens are a strange animal which had a proboscis and was related to *Merycochœrus*, a hog-like animal, the first found in America, and a skull of the so-called *Blastomeryx*, of the *B. borealis* type, with a mandible, proving that it is *Palæomeryx*. Nearly all parts of the skeleton of *Palæomeryx* were found. The *Merycochœrus*-like animal I have described

* See list of works on page 279.

under the name of *Merycochœrus laticeps* (1900); but since seeing the skulls of this genus in the American Museum of Natural History, I am inclined to think it will have to be given a new generic name. Both of these are vastly different from the John Day forms, *Promerycochœrus,* that have been put in this genus.

The beds underlying these look like some of the Oligocene east of the main divide. They are light colored. There are layers of limestone containing fresh-water snails. In one place there were thinly laminated shales with a few fish remains.

A few miles to the northeast, on the north side of the Hell Gate river, in gray sandy bluffs, the skulls of a dog much like *Temnocyon,* a *Leptomeryx,* and an Oreodont were discovered. These beds may be John Day.

Before going to a new field Prof. Smith was called away and Mr. Homer McDonald, a student of the University, accompanied me during the remainder of the time. After obtaining a few remains of a large rhinoceros, a large camel, and some poorly preserved mastodon teeth from the later Tertiary in the Deer Lodge valley, we crossed the divide southwest of Butte.

Near Whitehall, at two localities on Pipestone creek, one near Pipestone Springs and one on a branch called the Little Pipestone, were limited exposures where many small bones, teeth, and fragments of jaws were found. These were associated with distinguishable *Titanotherium* remains which were not of the largest species.

After making a valuable collection here we moved eastward, examining the Tertiary deposits on the North Boulder and obtaining jaws and teeth of a *Protohippus.*

Northwest of Three Forks are gray beds composed of fine material containing lime and looking much like the beds on Pipestone creek. There are also layers of hard limestone which break into angular fragments. Here there were a good many *Titanotherium* remains. We obtained large parts of two skeletons and other bones. Some interesting little Oreodonts, including a little *Agriochœrus,* were obtained, descriptions of which will be found in this paper.

Last spring (June, 1900) I again started from Missoula, going up the Big Blackfoot river, hoping to find Tertiary deposits on this river or on Nevada creek, one of its principal branches. The country around Ovando is covered with glacial drift, but on the road from that place to Helmville, near where it crosses the Big Blackfoot, the drift becomes thin and finally vanishes. The river cuts into the Tertiary deposits, in some places making quite high bluffs. I found no fossils here except wood fragments, but the beds are undoubtedly Oligocene (White River or John Day). After passing through a quite long cañon in going southeast up Nevada creek, the Tertiary appears again. The rock is mostly soft, but in places thousands of flint fragments have weathered out and are scattered over the surface. In some of these there are fossil snails. A few miles north of

Avon some bone fragments were found, which confirmed the belief that these beds are Oligocene.

After crossing a basaltic lava flow south of Avon the Tertiary beds appear again, but the fossils obtained here, as previously stated, are of later date, being either Miocene or Pliocene. Continuing my course southward I found that south of Silver Bow, as had been mistrusted, the lake bed deposits were continuous across the main divide. It is evident that previous to Miocene times a river had carved out a broad valley across what is now the watershed that divides the waters of the Atlantic from those of the Pacific; so the divide then occupied a different position from what it does now. In Tertiary times, probably by the formation of a great lake, this valley was partly filled with sediment, and after the drying up of the lake the drainage was changed. It is very probable that at some time during the Tertiary a lake extended from the northern part of the Deer Lodge valley southward to the Big Hole, eastward to the Jefferson, then northeastward to the Missouri river and down the Missouri to the region of Helena, a distance of 180 miles. There is no barrier and it is evident that there was none, and the Tertiary deposits can be traced the greater portion of the way. This, of course, may have happened more than once. A little south of the divide, on Divide creek, part of the skull and skeleton of a small horse was obtained.

There are only three regions from which fossils have been secured sufficiently abundant and characteristic, so that it can be positively stated now that the strata are White River; but there are other regions that are only a little doubtful. I believe that the White River, like the Loup Fork, occurs in all the principal valleys of southwestern Montana.

There is some doubt concerning the John Day. The lower Deep River beds near White Sulphur Springs appear to belong to that age (Scott, 1893), and some fossils in my collection, especially those obtained east of Drummond, appear to be more like John Day than White River, but there are not enough to settle the question.

The three regions that are certainly White River are: (1) on Pipestone creek, (2) on Thompson creek northwest of Three Forks, and (3) northeast of Toston near Cottonwood creek. Those on Blacktail Deer creek are probably White River. For convenience, until the strata in the different localities are satisfactorily correlated, I will give them local names.

White River Oligocene.

Pipestone Beds.

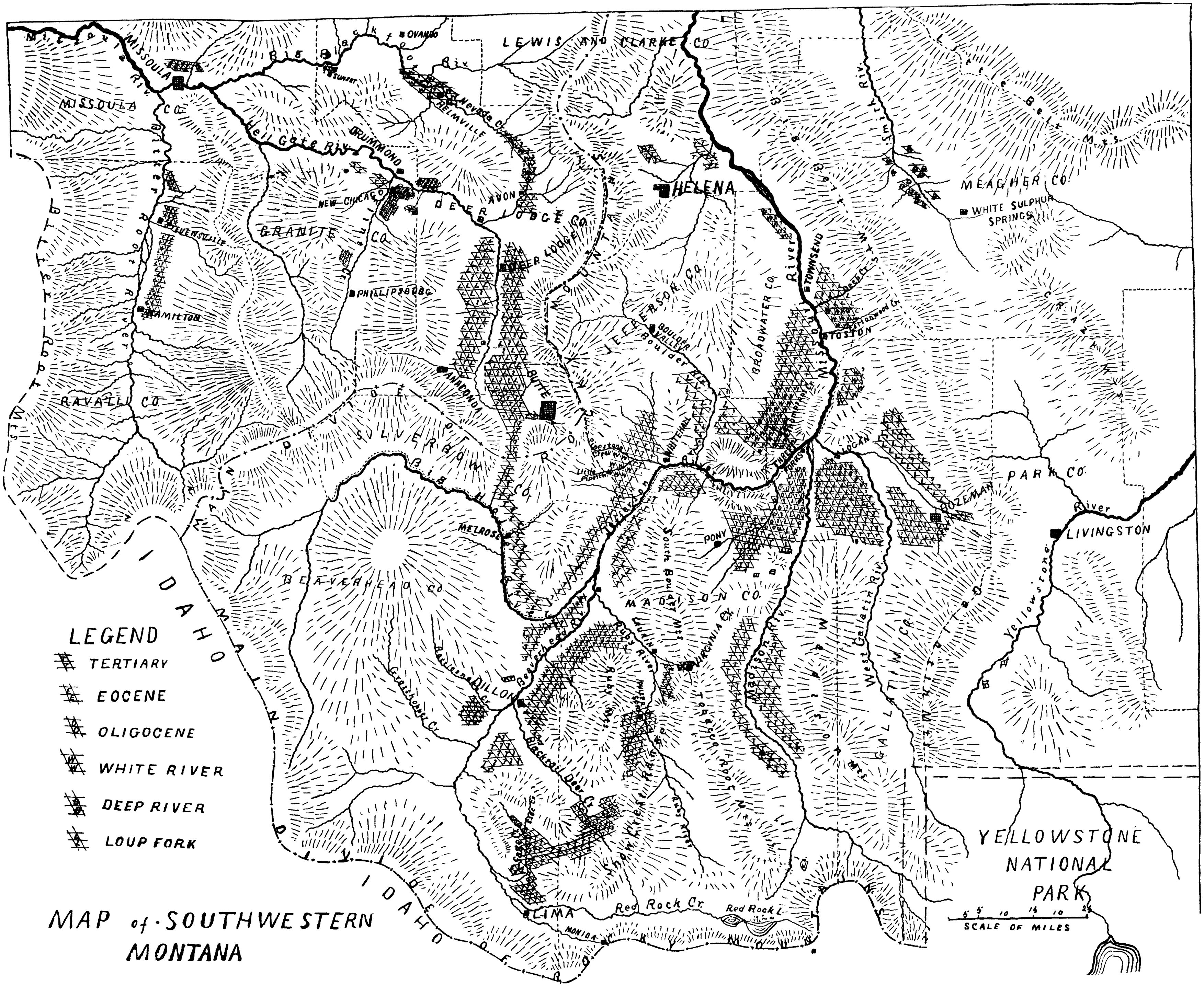
These are on Pipestone creek at two localities, one on the Big Pipestone near Pipestone Springs and the other on a branch, the Little Pipestone. The first is north of west and

Explanation of Map.

The map shows only approximately the Tertiary areas, as their limits have not been mapped or accurately defined. I have personally observed the Tertiary deposits in all the regions in which they are indicated, except in the small areas in the Yellowstone valley.

Where there is doubt as to the subdivisions the general term Tertiary has been used. By Oligocene, White River or John Day is meant. In the small spot marked Eocene (?), near Lima, fossils were found, but they appear so contradictory that it was thought best not to publish descriptions of the fossils until the beds were reëxamined and a solution of the problem found.

Places marked W ? L ? etc., indicate that the beds are doubtfully White River, Loup Fork, etc.



MAP of SOUTHWESTERN MONTANA
LEGEND
TERTIARY
EOCENE
OLIGOCENE
WHITE RIVER
DEEP RIVER
LOUP FORK
MISSOULA
MISSOULA CO.
LEWIS AND CLARKE CO.
HELENA
MEAGHER CO.
WHITE SULPHUR SPRINGS
GRANITE CO.
DEER LODGE CO.
RAVALLI CO.
SILVER BOW CO.
BUTTE
ANACONDA
PHILIPSBURG
NEW CHICAGO
DRUMMOND
AVON
HELMVILLE
OVANDO
HAMILTON
BROADWATER CO.
TOWNSEND
TOSTON
BOULDER VALLEY
WHITEHALL
MADISON CO.
PONY
VIRGINIA CY.
BEAVERHEAD CO.
DILLON
MELROSE
LIMA
MONIDA
Red Rock Cr.
Red Rock L.
GALLATIN CO.
BOZEMAN
LOGAN
PARK CO.
LIVINGSTON
YELLOWSTONE NATIONAL PARK
West Gallatin Riv.
Madison Riv.
Missouri River
Yellowstone River
Smith Riv.
Hell Gate Riv.
Beaverhead R.
Big Hole R.
IDAHO
SCALE OF MILES

the second south of west of Whitehall, in Jefferson county. The strata containing the bones are a sandy clay that swells and cracks on weathering and crackles under the feet when dry, and a light-gray fine-grained homogeneous material. Under the microscope the latter shows many angular, glassy fragments, which are undoubtedly volcanic dust. The fossils have not all been determined. Most of them are new. The following is a partial list:

Ictops acutidens, sp. nov.
Eumys minor, sp. nov.
Cylindrodon fontis, gen. et sp. nov.
Sciurus jeffersoni, sp. nov.
Ischyromis typus Leidy.
Palæolagus temnodon, sp. nov.
Palæolagus triplex (?) Cope.
Palæolagus turgidus (?) Cope.
Hyænodon minutus, sp. nov.
Agriochærus maximus, sp. nov.
Mesohippus bairdi (?).
Leptochærus.
Leptomeryx.
Hyracodon.

Thompson Creek Beds.

These are well exposed on a creek draining a small region northwest of Three Forks. The stream is small and nearly dry in summer, and I do not know that it is named on any map, but I have called it Thompson creek from the only man who lives near it. If they were called Three Forks beds they would be confused with the Three Forks formation which is Devonian. In these beds are the cracking clays above mentioned as occurring on Pipestone creek, also light colored material resembling that occurring at that place but containing lime. There are layers of limestone and strata of hard sandstone.

Most of the fossils were found on the north branch of Thompson creek near the road to Boulder. Farther to the southwest are large quantities of fossil wood, but only occasional bone fragments. The most abundant vertebrate remains are bones of Titanotheres. These have not been studied, but they do not belong to the largest species.

List of Fossils.

Limnenetes platyceps, gen. et sp. nov.
Limnenetes (?) *anceps*, sp. nov.
Agriochærus minimus, sp. nov.
Mesohippus.
Colodon.
Titanotherium.

Toston Beds.

These are exposed northeast of Toston, which is a small railroad station on the Missouri river below Three Forks and above Townsend. They are about twenty-five miles north and east of the Thompson Creek beds. While the last named deposits apparently belong to the lower White River or Titanotherium horizon, part, at least, of these seem to

more nearly correspond to the Oreodon division. Among the fossils are three very good skulls of Oreodonts. One I have referred to the genus *Eucrotaphus,* one is a new species of Oreodon and one is much like *O. culbertsoni.* A good portion of the skeleton of the latter was found, but there has not been time to clean it and make careful comparisons. It is probable that it will have to be referred to a new species.

These and other Oreodont remains were in the cracking, sandy clays which contain nodular layers. A *Titanotherium* tooth was found in the same kind of clay but perhaps a trifle lower down. *Colodon* and *Hyænodon* teeth and jaws were obtained, but I cannot state with certainty their relation to the beds above mentioned. The strata here are considerably disturbed, and in some places dip to the eastward as much as 30° to 40°. In the ardent work of collecting I had not the time to study the geology of the region as much as I hope to do later. Lying unconformably on these deposits in places are nearly horizontal strata of later date, either Miocene or Pliocene.

List of Fossils.

Hyænodon montanus, sp. nov.	*Colodon,* sp.
Oreodon robustum, sp. nov.	*Mesohippus.*
Eucrotaphus helenæ, sp. nov.	*Titanotherium.*
Colodon cingulatus, sp. nov.	*Cænopus* (?).

The Blacktail Deer Creek Beds.

These are on Blacktail Deer creek, about thirty miles south and east of Dillon. The exposure is small and only a few fossils were found. The material, as in the localities previously mentioned, is mostly light colored and fine grained, yet there are thin strata of sandstone. None of the fossils positively determine the horizon. There was the new genus *Arretotherium,* part of the back of a skull of *Cænopus* about the size of *Aceratherium tridactylum* Osborn, and part of a mandible of *Steneofiber hesperus* sp. nov. which is described in this paper.

List of Fossils.

Steneofiber hesperus, sp. nov.	*Arretotherium acridens,* gen. et sp. nov.
Cænopus (?).	

The skull of *Steneofiber complexus,* described in this paper, came from the beds on the west side of the Madison river above Three Forks (Douglass, 1899, p. 4). The locality is about fifteen miles south of where the fossils occur in the Thompson Creek beds. Near the same place were a femur, tibia, fibula and calcaneum of a rather long-limbed Perissodactyl, probably a rhinoceros, but the deposits here contain very few fossils.

There are turtle remains in all the beds above described.

Besides the above there are at least three localities where fragments of fossils that are almost certainly White River have been collected. They are north of Avon in Deer Lodge county, at Glendale in Beaverhead county, and west of Puller Springs near the Ruby river in Madison county.

In Montana vertebrate fossils of the Tertiary have not been found in anything like abundance except at two or three restricted localities, and these long distances apart, though a few have been found in as many as twenty different places. In the White River they were the most numerous on Pipestone creek, but they are mostly isolated teeth, jaws and other bones of small animals. Certain strata are quite rich in fossils, but on account of their dip and their being, as a rule, covered with vegetation or débris, they are exposed for only short distances. It is curious, though, that in all the beds in which collecting has been done surprisingly few duplicates have been obtained, and few of the things have been found anywhere else. The White River collection, as it has been studied and compared with those of other regions, has caused continual surprise on account of its great difference from them. The explanation seems to lie partly in the fact that in Montana we have quite a rich fauna from a horizon nearly or quite corresponding to the lower White River or Titanotherium beds of South Dakota, where few fossils except Titanotheres have been found. Though the fossils were scattered over a large area (about 150 by 170 miles) and were not especially abundant, yet during the six years that I spent in Montana a good-sized collection was secured.

Most of my time while in the field has been employed in the search for fossils, and I have never seen the corresponding Tertiary formations in other regions, yet I have made some observations that may be interesting. W. D. Matthews' paper, "Is the White River Tertiary an Æolian Deposit?" (*Amer. Nat.*, May, 1899), has added new interest to the study of these so-called lake bed deposits. There certainly is much mystery concerning their origin and the way in which the animal remains became fossilized. The fossils from Montana are different in appearance and are enclosed in a different matrix from those that are found in South Dakota. As has been said of the former (referring to color, etc.), "They do not look like White River fossils."

Most of the material in the beds that are undoubtedly White River is light colored, fine grained, and soft, though there are some layers of coarser and harder material. The same is true of the beds that, from their lithological characters and imperfect fossils, have been supposed to belong to the same horizon. The nearness or distance of the shore or the mountains and the character of the contiguous rocks seem to have little influence on the character or composition of the sediments.

I have made microscopic examination of samples from the several fossil-bearing beds, and all contain minute fragments undistinguishable from the glass fragments from the

beds of pure volcanic dust in the Loup Fork of Montana. It is very likely that the greater part of the deposits are a mixture of clay, fine sand and volcanic dust, with an abundance of calcareous matter in some places. Often, as previously stated, there are strata of limestone. In many places this limestone contains an abundance of fresh-water shells. These have not yet been specifically determined. Sometimes for a considerable thickness there is no distinct stratification, and in other places there are thin layers and distinct lamination. Near New Chicago, in thinly laminated shales, a few fish remains were found, and a little distance away, in a harder layer, fragments of bone, including part of a metapodial of an Oreodont associated with snails.

If the beds that do not contain fossil mammals, but have the same appearance as those that do contain them, are of the same age as the latter, there was a large area of deposition in Montana.

There has been considerable disturbance since the deposition of the White River beds, for in some places the strata dip at a high angle. I have not seen any distinct shore markings except in the vicinity of Missoula, where there was undoubtedly a lake in Pleistocene times.

The work on this paper has been done in the Museum of Princeton University, to which the greater part of my collection has been removed for study. It is due to the broad-minded interest of Prof. W. B. Scott that I have been enabled to do the work under such favorable circumstances, and his intelligent criticism has been of the greatest value to me. Dr. Marcus S. Farr, the Curator of Vertebrate Palæontology, has given me free access to the Museum and helped me in every possible way. The drawings of fossils were made by Mr. F. Von Iterson. The map was drawn by myself.

All the specimens described in the paper were found in Montana by myself and they are now in my collection, to which the numbers in the text refer.

PRINCETON MUSEUM, May 2, 1901.

DESCRIPTIONS OF SPECIES.

Ictops acutidens, sp. nov.

The type, No. 36 of my collection, consists of portions of a skull, mandible and other bones with a nearly complete femur, astragalus, calcaneum and one lumbar vertebra. It was a young individual. The epiphyses are free and the last lower premolar erupting. I do not know whether the last two upper premolars are permanent or temporary, but will describe them as they are.

If full grown the animal was smaller than *I. dakotensis** and differs from it in several

* Compared with specimen in the American Museum of Natural History.

respects. $P^{\underline{3}}$ is much larger and more complex, but it may be a temporary tooth. There are quite prominent antero-external cusps on the last two premolars and the first two molars.

Superior Dentition.—$P^{\underline{3}}$ has four sharp cusps, three of which—the protostyle, protocone and tritocone—are in an antero-posterior line. The protocone is the largest and is high and pointed. The tritocone is larger than the protostyle. The deuterocone is opposite the interval between the protocone and tritocone. This tooth is the longest of those that are preserved in the upper jaw.

$P^{\underline{4}}$, like the molars, is wider than long. It has four primary cusps—the protocone, tritocone, deuterocone and tetartocone—and three secondary ones—a protostyle and an anterior and a posterior median conule. The protocone and tritocone are high and pointed, the first being slightly the higher. The tetartocone is prominent but not high. The protostyle forms a small but distinct antero-external cusp. The protoconule and metaconule are plainly distinguishable (with a lens) on the protoloph and metaloph.

$M^{\underline{1}}$ is almost like $P^{\underline{4}}$ except that it is wider and the protoconule is merged into the protoloph which passes from the protocone to the parastyle. The metaconule is distinguishable. There is a small metastyle. $M^{\underline{2}}$ is wider than M^{1} but not so long. There is only a trace of a metastyle. M^{3} is small. The anterior elements are well developed, but the hypocone and metacone are much reduced.

Inferior Dentition.—The only premolar that is preserved is just erupting and is somewhat injured.

In all the molars the anterior cusps are much higher than the posterior ones. The protoconid and metaconid are connate at the base and the paraconid appears as a small anterior median cusp. The protoconid and metaconid are of a nearly equal height. In the heel or talonid the hypoconid is somewhat larger—has a greater antero-posterior diameter than the entoconid. The hypoconulid is median and small. The other molars are formed in the same pattern, but they decrease slightly in size posteriorly.

The infraorbital foramen opens above $M^{\underline{1}}$, is narrow transversely and opens diagonally upward. It is in a longitudinal concavity which extends backward a short distance on the anterior part of the zygomatic arch. The posterior part of the foramen is only a little in advance of the anterior of the orbit. At the anterior upper margin of the orbit is a quite large protuberance.

The horizontal ramus of the mandible is narrow vertically. The angle projects downward and backward, the posterior angle being slightly hooked upward. The condyle is just above a line passing through the highest points of the molars. It is disk-shaped, the broad articular surface facing backward as much as upward. The coronoid process is broad. The tip is broken off. The anterior angle of the masseteric fossa is considerably behind the last molar and below the alveolar border. It is quite deep and

the anterior ridge prominent. On the inside of the mandible a convexity runs forward, dying out in a narrow ridge on the alveolar border under $M_{\overline{3}}$.

The great trochanter of the femur is not high. The lesser one is prominent posterior to and a little below the head. The third trochanter is small. The middle part of the shaft is nearly circular in section.

Measurements.

UPPER JAW.

	M.
Length of last two premolars and the true molars	.0137
Length of molar series	.0068
Length of $P^{\underline{3}}$	.0034
Width of $P^{\underline{3}}$	.0023
Height of crown of $P^{\underline{3}}$	.002
Lenth of $P^{\underline{4}}$	.0031
Width of $P^{\underline{4}}$	.0033
Length of $M^{\underline{1}}$	.003
Width of $M^{\underline{1}}$	.004
Length of $M^{\underline{2}}$	.0026
Width of $M^{\underline{2}}$	.004
Length of $M^{\underline{3}}$	.0016
Width of $M^{\underline{3}}$	.0031

LOWER JAW.

Length of molar series and last premolar	.012
Length of molar series	.0085
Length of $P_{\overline{4}}$	.0035
Length of $M_{\overline{1}}$	.0028
Width of $M_{\overline{1}}$	.0021
Height of $M_{\overline{1}}$	.003
Length of $M_{\overline{2}}$	.003
Length of $M_{\overline{3}}$	.0025
Width of $M_{\overline{3}}$	.0019
Height of $M_{\overline{3}}$	.0024
Depth of ramus under $M_{\overline{1}}$	.0051
Depth of ramus under $M_{\overline{3}}$	.0041
From posterior of $M_{\overline{3}}$ to posterior of condyle	.013
Length of femur	.046

Steneofiber hesperus, sp. nov.

Part of the left horizontal ramus of a mandible (No. 41) containing all the teeth. The tip of the incisor is gone. The specimen was found in a light colored sandy clay near Blacktail Deer creek, about thirty miles above Dillon in Beaverhead county. It was near the top of an exposure in which, a considerable distance below, were the remains of *Arretotherium*, to be described later, and part of the skull of a quite large rhinoceros.

The mandible is somewhat smaller than that of *S. pansus* of the Loup Fork of New Mexico. It is less robust, not being so deep or thick. The masseteric area does not extend so far forward. There is some difference in the enamel pattern of the teeth, but just how much is due to wear I cannot say. That of the premolar in the present species is more complex, being crenulate or minutely folded on the inner lakes and inflections. This tooth is smaller especially at the top, but much wear would bring this surface nearer to the area of that of *S. pansus*. The two anterior molars are broader and longer. The teeth do not appear so high from the outside, but are higher above the alveolar border on the inside. The outer enamel inflections do not extend so far down on the outside of the teeth, are more open and incline more forward and the outer lobes are more angulate. There are small extra enamel islets on $M_{\overline{1}}$ and $M_{\overline{2}}$. There is no sharp antero-internal angle on the premolar. These comparisons are made with No. 10575 of the Princeton collection labeled *Castor pansus*, Camp creek, Oregon, which evidently does not differ at all from Cope's type from New Mexico (1877, p. 297, Pl. LXIX, Figs. 4 and 5).

In none of the teeth are the principal inner and outer enamel inflections converted into lakes.

At its preserved stage of wear the grinding surface of $P_{\overline{4}}$ has three divisions, an anterior outer, an anterior inner and a posterior. The anterior outer division is three-lobed, or is a crescent with a long limb extending inward and somewhat backward from near the posterior horn. The anterior horn is at the antero-external angle of the tooth. From this the crescent sweeps backward and inward, the outer border forming the outer margin of this part of the premolar. The inner limb extends transversely inward to the inner border. The anterior inner crescent of the tooth begins near the anterior border of the preceding one, the outer margin forming the anterior and anterior inner border of the tooth. On the posterior part of this crescent near the antero-external horn is a rounded lobe. Much wear would make the two anterior crescents confluent. The posterior part of the tooth is a transverse, pointed oval with the smaller end outward and slightly deflected forward. Its enamel lake has nearly the same form but with sinuous margin Much wear would perhaps make the enamel pattern nearer like that of *S. pansus*.

The enamel folds and lakes are inclined to be more curved and the enamel borders more sinuous than in *S. pansus*. There is an extra islet in the two anterior molars. In $M_{\overline{1}}$ it is posterior to the anterior lake and in $M_{\overline{2}}$ it is anterior.

The anterior surface of the incisors is more convex than in the beaver, *Castor canadensis*, and the antero-posterior diameter is proportionally greater.

Measurements.

	M.
Length of molar-premolar series	.017
Length of $P_{\overline{4}}$ at base	.005

	M.
Width of $P_{\overline{4}}$ at base	.0045
Length of $M_{\overline{1}}$	.004
Width of $M_{\overline{1}}$	.0045
Length of $M_{\overline{2}}$	.004
Width of $M_{\overline{2}}$	.0042
Length of $M_{\overline{3}}$	.004
Width of $M_{\overline{3}}$	.0036
Depth of ramus under middle of $P_{\overline{4}}$	.012
Depth of ramus under posterior of $M_{\overline{1}}$	.011

Steneofiber complexus, sp. nov.

The type of this species is part of a skull and mandible with complete dentition (No. 42). It was found in a gray sandy layer in a ravine cutting through high bluffs of supposed White River age on the west side of the Madison river, in the Lower Madison valley, about nine or ten miles south of Three Forks. As this specimen and some limb bones of a rhinoceros-like animal are the only fossils of importance obtained here, and as the exact relations with the lower White River fossil-bearing beds northwest of Three Forks, about fourteen miles distant, have not been made out, it is impossible to say to just what horizon these beds belong.

This is a young individual. Only one premolar—the right upper one—has been shed. All of the molars are fully protruded and considerably worn. The upper permanent premolars are farther advanced than the lower, which evidently had only begun to grow.

This species seems to be nearest like Cope's *S.* (*Castor*) *peninsulatus* (1883, p. 840, Pl. LXIII, Figs. 18–21). The skull is damaged, yet some points of interest can be made out. There is a marked difference in the mandibles of the two species. In the present one the masseteric area does not extend so far forward, the anterior margin of the coronoid process rises opposite the back part of the third cheek tooth ($M_{\overline{2}}$), and is nearer to the molars. This process has an entirely different form in the present species. It is high; the anterior border is straight and rises steeply. The angle is inflected inward and is rounded, not angulate anteriorly and posteriorly as in *S. viciacensis* (see Filhol, 1891, Pl. 5).

The Dentition.—The anterior face of the lower incisor is not so convex as in *S. hesperus* just described. The posterior angle is not so acute but is broadly rounded. The outer part of the cutting edge is rounded, not angulate, and the inner worn, beveled surface is long and longitudinally concave. Below this the transverse is just a trifle greater than the antero-posterior diameter.

The upper cheek teeth are very complex on account of the number and the curving of the enamel lakes and inflections and the sinuosity of the enamel. This might be simplified on further wear. The inner loops extend forward as much as outward, and some of

the lakes are nearly antero-posterior. In the lower teeth also the enamel of the lakes and inner enamel inflections is much lobed.

I will defer a detailed description of these teeth for a paper which has been partly written, describing several new species of Mylagaulidæ and throwing considerable light on their development.

Measurements.

SKULL.

	M.
From anterior of incisor to posterior of M^3	.0384
From posterior of incisor to anterior of P^4	.021
Transverse diameter of incisor	.0032
Antero-posterior diameter of incisor	.0033
Length of molar-premolar series	.0123
Length of temporary P^4	.0033
Width of temporary P^4	.0038
Length of M^1	.0032
Width of M^1	.0035
Length of M^2	.0032
Width of M^2	.0034
Length of M^3	.0022
Width of M^3	.0032

LOWER JAW.

Anterior tip of incisor to posterior of M_3	.033
Length of molar-premolar series	.0146
Length of P_4	.0038
Width of P_4	.003
Length of M_1	.003
Width of M_1	.004
Length of M_2	.0032
Width of M_2	.004
Length of M_3	.0032
Width of M_3	.0033

Palæolagus Leidy.

In the Pipestone beds quite a number of jaws and teeth of *Palæolagus* were found. They apparently belong to three species. One has the third column on the lower molars as in *P. triplex.* The three portions of mandibles preserved are somewhat smaller than the one described by Cope (1883, p. 881, Pl. LXVII, Fig. 28), and may belong to a different species.

Several upper and lower jaws I cannot distinguish from *P. turgidus.*

Palæolagus temnodon, sp. nov.

There are three series of upper teeth (Nos. 43, 44 and 45) which differ in some respects from previously described species. They vary somewhat in size. P^3—the first

cheek tooth—has two anterior grooves instead of one. It lops backward, its upper posterior part resting against P^4. On M^3 of the largest one (No. 42) there is a rudiment of a posterior lobe. From Pipestone creek.

Measurements.

	No. 43.	No. 44.
	M.	M.
Length of molar-premolar series	.0123	.0141
Length of molar series	.0051	.0061
Width of M^1	.0004	.0045

Cylindrodon fontis, gen. et sp. nov. (Plate IX, Figs. 9, 9*a*.)

Of this rodent I have two portions of right mandibular rami (Nos. 38 and 39). One has all the cheek teeth and the greater part anterior to the ascending ramus; the other has the three posterior teeth and part of the ascending ramus, but not the angle, coronoid process or condyle. They were obtained from the Pipestone beds, associated with *Palæolagus*, *Ischyromis*, etc. The Pipestone springs, near where the fossils were found, suggested the specific name.

The diastema was short; the teeth are cylindrical with a central enamel islet and an outer enamel inflection. The lower border of the ramus is convex fore-and-aft, and is shallow but thick under $M_{\overline{3}}$. The anterior angle of the masseteric area extends forward to $M_{\overline{1}}$ and is near the alveolar border. The anterior border of the ascending ramus rises opposite $M_{\overline{3}}$ and leaves a broad space between the two. The surface of the masseteric area is nearly flat, with a convexity considerably behind and above its anterior angle. On the inside, back of the teeth, from the horizontal ramus a large convexity passes backward, outward and upward on the ascending ramus. Above and below this the bone is thin. The mental foramen is small and is situated above the middle of the jaw, a little in advance of $P_{\overline{4}}$.

The teeth are very characteristic, yet they are simple. As seen from above they look like a large comma, with a short tail directed outward. Their order of size, beginning with the smallest, is $M_{\overline{3}}$, $P_{\overline{4}}$, then $M_{\overline{1}}$ and $M_{\overline{2}}$, which are nearly equal in size. The teeth are evidently quite long vertically, except the last which is short, as it is so nearly approached by the posterior portion of the canine. The incisors are thicker antero-posteriorly than transversely.

Measurements.

	M.
Length of molar-premolar series	.0076
Depth of ramus under $P_{\overline{4}}$	.0064
Depth of ramus just back of $M_{\overline{3}}$	.0046
Thickness of ramus under $P_{\overline{4}}$	.003

	M.
Thickness of ramus at $M_{\overline{3}}$	.004
Length of $P_{\overline{4}}$	.003
Width of $P_{\overline{4}}$	.0021
Length of $M_{\overline{1}}$	.0031
Width of $M_{\overline{1}}$	.0022
Length of $M_{\overline{2}}$	.0021
Width of $M_{\overline{2}}$	.0022
Length of $M_{\overline{3}}$	.0014
Width of $M_{\overline{3}}$	.0015

Sciurus jeffersoni, sp. nov.

Type No. 40.

This species is larger than *S. relictus* (Cope, 1883, p. 817, Pl. LXV, Fig. 35). The teeth do not increase regularly in size backward. The mental foramen is higher and nearer to the incisor. The diastema was shorter.

In this species the anterior cheek tooth is the smallest and the posterior one the largest, but the two between are nearly equal in size. In all of the teeth the anterior inner tubercle is the higher and larger and the posterior inner one the smaller. The latter does not appear as a separate tubercle on $M_{\overline{3}}$, as a continuous wall extends from the anterior inner to the posterior outer one, enclosing the basin internally and posteriorly. A small ridge, which may represent the posterior inner tubercle, extends from the wall backward and inward in the posterior part of the basin. On the anterior three teeth there are minute tubercles between the two internal ones. There are also minute median tubercles on the outer margins of all the teeth.

From White River beds, Pipestone creek.

Measurements.

	M.
Length of lower molar-premolar series	.012
Length of $P_{\overline{4}}$	.0026
Width of $P_{\overline{4}}$	.0029
Width of molars, each	.003
Length of $M_{\overline{1}}$	.0029
Length of $M_{\overline{2}}$	.003
Length of $M_{\overline{3}}$	.004

Eumys minor, sp. nov.

The type of this species, No. 37, is part of a right ramus of a mandible from the Pipestone beds on Pipestone creek, in Jefferson county. The anterior part of the incisor is gone and all of the mandible back of the second molar. The two anterior molars are perfect.

This species is much smaller than *E. elegans* Leidy. The mental foramen is near the upper border of the diastema and apparently much in advance of the middle. The anterior angle of the masseteric area is under the anterior molar. Both teeth are somewhat worn on their grinding surfaces. Their antero-posterior diameters are nearly equal, but the second is broader transversely than the first. The anterior part of the first molar (cheek tooth) is not plainly divided into two lobes, but is subconical with a pit in the middle of the truncated apex. Its transverse is greater than its antero-posterior diameter. It is not much worn. It is smaller than the posterior portion of the tooth, in which there is a posterior outer tubercle, from which three slender lobes extend inward. The anterior lobe is the longest and the posterior the shortest. The second tooth has the two rounded outer tubercles and five slender inner lobes. It looks as if each outer tubercle sent in three inner lobes, but the contiguous two unite to form one median one. On looking at the grinding surface, it is not easy to make out the four principal lobes as it is in Leidy's figure of a tooth of *E. elegans* (1869, Pl. XXVI, Fig. 13). On examining the tooth from the inside it is seen that, beginning anteriorly, the second lobe forms the large anterior inner tubercle and the fourth the posterior one. The first and fifth are accessory, and the third is in the median valley between the two tubercles. It seems that a little further wear would unite the two anterior lobes.

Measurements.

	M.
Depth of jaw at mental foramen	.0031
Depth under second molar	.0039
Thickness under second molar	.0025
Length of first molar	.0015
Width of first molar	.0013
Length of second molar	.0015
Width of second molar	.0017

Hyænodon montanus, sp. nov.

Type No. 46.

A portion of a skull and mandible with all the teeth represented except the lower incisors. Found northeast of Toston, a village on the Missouri river, southeast of Helena. This was the only fossil secured from this stratum; but teeth of two species of *Colodon* were found in lower strata. The skulls of *Oreodon robustum*, *O. culbertsoni* (?), and *Eucrotaphus helenæ* were found farther to the northeast, but I am not sure whether the beds are higher or lower.

Larger than *H. crucians;* crown of upper canine nearly straight; crown of P^2 high and without posterior cusp; talons on $P_{\overline{3}}$ and $P_{\overline{4}}$, but not on $P_{\overline{2}}$.

The canine is long and slender but not curved backward toward the apex. $P^{\underline{2}}$ has a high crown as in *H. cruentus* and *H. horridus.* It has no heel and is therefore nearly like that of the former species. The anterior border is only slightly convex longitudinally. The posterior is concave as in that species. There is a small tritocone on $P^{\underline{3}}$, and the rudiment of a deuterocone supported by an inner root. In $P^{\underline{4}}$ the tritocone, the deuterocone and its supporting root are all larger. There is no antero-external basal cusp.

The lower canine curves backward. $P_{\overline{1}}$ is small and low, $P_{\overline{2}}$ bends backward. It is higher than $P_{\overline{3}}$. $P_{\overline{4}}$ is much larger and higher than $P_{\overline{3}}$.

Measurements.

UPPER JAW.

	M.
Length of upper series of teeth, exclusive of incisors	.094
Length of upper molar-premolar series	.083
Length of upper premolar series	.053
Length of upper canine	.012
Width of upper canine	.0083
Height of crown of upper canine	.026
Length of $P^{\underline{1}}$	.009
Height of crown of $P^{\underline{1}}$	.007
Length of $P^{\underline{2}}$	.0125
Height of $P^{\underline{2}}$	.014
Length of $P^{\underline{3}}$	.0135
Height of $P^{\underline{3}}$	.010
Length of $P^{\underline{4}}$	.013
Height of $P^{\underline{4}}$	.011
Length of $M^{\underline{1}}$	.013
Height of $M^{\underline{1}}$	.010
Length of $M^{\underline{2}}$	.017
Height of $M^{\underline{2}}$	.011

LOWER JAW.

Length of lower series of teeth, exclusive of incisors	.092
Length of lower molar-premolar series	.090
Length of lower premolar series	.052
Length of lower molar series	.039
Length of lower canine	.011
Width of lower canine	.0095
Length of $P_{\overline{1}}$	.008
Height of $P_{\overline{1}}$	.004
Length of $P_{\overline{2}}$	.011
Height of $P_{\overline{2}}$	.010
Length of $P_{\overline{3}}$	.0125
Height of $P_{\overline{3}}$	.011
Length of $P_{\overline{4}}$	.0133

	M.
Height of $P_{\overline{4}}$	.012
Length of $M_{\overline{1}}$	.0095
Length of $M_{\overline{2}}$	.0105
Height of $M_{\overline{2}}$	.010
Length of $M_{\overline{3}}$	.017
Height of skull above $M^{\underline{1}}$ about	.062

Hyænodon minutus, sp. nov.

Type No. 47.

This consists of only a lower sectorial tooth, but it is so minute that it cannot be confused with any known species, unless it be *H. mustelinus*, which is considerably larger. It is the second molar of the right side. It shows considerable lateral wear on the outside, showing that it was not a young animal. At the top of the cusp are two beveled, worn surfaces, where the white dentine shows through the black enamel. The dentine also is exposed on the anterior surface near the root. The tooth is thick in proportion to its length. There are minute ridges on the anterior angles and a faint median convexity. There is also a minute ridge in the posterior median surface. Probably the most characteristic thing is the size.

Measurements.

	M.
Antero-posterior diameter	.0075
Transverse diameter	.0049

From Pipestone beds near Whitehall, Jefferson county, Montana.

Colodon cingulatus, sp. nov.

Type No. 62.

Part of maxillary with $P^{\underline{3}}$, $P^{\underline{4}}$, $M^{\underline{1}}$ and base of $P^{\underline{2}}$.

A prominent cingulum entirely surrounds the last two premolars. The internal cusps—the deuterocone and tetartocone—are just beginning to divide, as indicated by a shallow furrow on the inner side. The protostyle, protocone and tritocone are all convex on the outside. The protocone and tritocone are nearly equal in size, but the protostyle is not so large or high. The metaloph is higher than the protoloph, the latter nearly dying out before it reaches the protocone. In other words, it ascends steeply as it passes outward toward the protocone.

In $M^{\underline{1}}$ the paracone, parastyle, metacone and hypocone all appear as subconical cusps. The parastyle is much smaller than the paracone, and is situated in front of it and does not send backward a prominent cingulum on the outer face of the paracone as in *C. procus-*

pidatus. The distance from the apex of the paracone to the apex of the metacone is the same distance as from the latter to the apex of the hypocone.

There are at least two infraorbital foramina. They open in a concavity in the face above the third and fourth premolars.

From Toston beds near the Missouri river, above Townsend.

Measurements.

	M.
Length of last three premolars and first molar	.0407
Length of P^2 at base	.009
Width of P^2 at base	.012
Length of P^3	.0115
Width of P^3	.0173
Length of P^4	.012
Width of P^4	.0182
Length of M^1	.0145
Height of infraorbital foramina above alveolar border	.018
Distance between the two infraorbital foramina exposed	.0065

Colodon, sp.

No. 63.

A last upper molar in a fragment of the maxillary.

This is larger than *C. dakotensis.* The tooth is considerably worn. The parastyle is as large as the paracone and is more convex on the outer surface. The metacone is small. From Toston beds.

Measurements.

	M.
Length of M^3	.020
Width of M^3	.022

Bathygenys, gen. nov. (Plate IX, Figs. 7 and 8.)

Type Nos. 48 and 66.

Among the remains of small animals that were found in the Pipestone beds are two portions of mandibles that are of much interest, as, disregarding size, they are so very much like the corresponding parts of some of the Loup Fork specimens from Montana that I have put in the genus *Merycochœrus* (1900 and 1901). I have not made a careful study and comparison, but since seeing the fine specimens of *Merycochœrus* in the American Museum of Natural History, I think it is very likely that the Montana forms above referred to should be put in a new genus, so I will at present refer these to *Merycochœrus* with a question mark, as: *Merycochœrus* (?) *laticeps*, *M.* (?) *altiramus*, etc.

The parts of the present specimens are small, being anterior fragments of mandibles, yet these parts are so perfectly characteristic in *Merycochœrus* (?) that I cannot avoid the belief that if the skull of this animal is found it will show a strong leaning toward that genus, and I would not be surprised if it proved to be the White River ancestor. This is made more probable by the fact that none of the *Oreodontidæ* that have been described can be considered as ancestral to *Merycochœrus*, either the true genus or the doubtful one. I do not refer to the John Day forms, *Promerycochœri*, which have been included in that genus. They are a very different animal.

The specimens are (48) the anterior part of a right ramus of a mandible, with part of the alveolus of the canine, the root of $P_{\overline{1}}$, the alveolus of $P_{\overline{2}}$ and the last two premolars complete, and (66) a part of a right ramus with the last three premolars and the first molar.

There are four ways in which it differs from *Merycochœrus* (?). It is only a fraction of the size; it has, like some species of *Leptauchenia*, two mental foramina; the premolar teeth are not crowded, and the teeth are not so high. The premolar series was probably as long as the molar series.

In the form of the chin and symphysis, the depth of the jaw, the narrowness of the space between the rami back of the symphysis, the evident reduction of the incisors, the smallness of the canine, the lenticular section of $P_{\overline{1}}$, the forms of all the teeth preserved, their narrowness in proportion to their length, are all like *Merycochœrus* (?). It may be that these two fragments belong to different species, so to save confusion I will describe them separately.

Specimen 48.—The anterior upper tip of the ramus is broken off. This shows anteriorly a transversely narrow broken surface, nearly in the middle of which is the canine alveolus, but no hint of incisors. It is very doubtful if there was the full number. If there was they must have been exceedingly small or placed anteriorly to the canine. The anterior surface of the chin as far as shown is steep and straight along the symphyseal suture. It is convex transversely. The anterior mental foramen is beneath the posterior part of $P_{\overline{3}}$, the posterior one a little behind the middle of $P_{\overline{4}}$. They are a little above the longitudinal middle line of the ramus. The anterior is the larger. The symphyseal suture is broadest below and narrows. upward as in *Merycochœrus* (?). The posterior of the symphysis is under the anterior part of $P_{\overline{4}}$.

The canine was evidently much smaller than $P_{\overline{1}}$. $P_{\overline{1}}$ is lenticular in section with nearly equal sides and rounded angles, the longest diameter being obliquely fore-and-aft, and directed posteriorly outward and anteriorly inward as in *Merycochœrus* (?). $P_{\overline{2}}$ had two roots near together. $P_{\overline{3}}$ has a proportionally large paraconid, which as the tooth is viewed from the outside is seen to be separated above by a distinct notch from the pro-

toconid. The deuteroconid is only represented by a narrow ridge passing part way down the tooth inward and backward from the apex of the protoconid. The metaconid is much better developed and is represented by a posterior tubercle, connected by a narrow ridge with the apex of the protoconid.

In $P_{\overline{4}}$ the paraconid is thicker and higher than in $P_{\overline{3}}$, and is inflected inward. The other four elements—the protoconid, metaconid, deuteroconid and tetartoconid*—are all well developed and surround a quadrangular cup-shaped depression. This is true also of *Oreodon* and *Eucrotaphus*, and the form of the tooth differs very little from these. In this particular tooth, however, the posterior depression would, on further wear, make an islet, not an enamel loop. It is shallow and would entirely disappear if there should be much wear. The great difference between this tooth and the corresponding ones of the above-named genera is in the narrowness of the tooth as compared with its length. $P_{\overline{3}}$ also differs in this respect and they are, therefore, more like *Merycochœrus* (?). $P_{\overline{3}}$ differs from that of *Oreodon culbertsoni* in the simplicity of the inner ridges—rudimentary deuteroconid—in this respect being much like the specimen I have examined of *O. gracilis.* It also differs in having the paraconid partly separated from the protoconid. Again in these slight variations the differences are in the direction of *Merycochœrus* (?). In the type of *M.* (?) *altiramus,* which I have described from the Loup Fork of Montana, the teeth are little worn and give an excellent opportunity for comparison (1901, p. 73, Fig. 1). The present species shows almost no advance on this pattern. The paraconid on the last two premolars is a little thicker, and this element is distinguishable on $P_{\overline{2}}$, which has just begun to develop the posterior elements. The teeth have all increased in height.

Specimen No. 66.—In this specimen the mental foramina are farther apart. The anterior one is under the anterior part of $P_{\overline{3}}$ and the posterior one under the anterior of $P_{\overline{4}}$. There is a thickening of the ramus—an outer convexity between these two foramina —not seen in No. 48.

$P_{\overline{2}}$ is shorter than $P_{\overline{3}}$ and the roots are not close together as in the other specimen $P_{\overline{3}}$ is about the same. $P_{\overline{4}}$ has the metaconid and tetartoconid much lower and they are not united at the posterior inner angle of the tooth, so that after considerable wear there would still be an opening to the inner basin as in *Oreodon* and *Merycochœrus* (?). $P_{\overline{3}}$ and $P_{\overline{4}}$ are broader than in No. 48.

$M_{\overline{1}}$ is shorter than $P_{\overline{4}}$. The posterior pair of crescents is wider than the anterior pair. The outer crescents are short antero-posteriorly.

I will propose for the specific name *P. alpha,* with No. 48 as the type specimen.

* The tetartoconid is small.

Measurements.

SPECIMEN 48.

	M.
Depth of jaw at angle of chin	.0155
Greatest width of symphyseal suture	.0083
Distance between mental foramina	.004
Thickness of ramus behind symphysis	.006
Length of premolar series	.0175
Length of $P_{\overline{1}}$	.0042
Width of $P_{\overline{1}}$	.0027
Length of $P_{\overline{3}}$	.005
Width of $P_{\overline{3}}$	.0022
Height of crown of $P_{\overline{3}}$	.0026
Length of $P_{\overline{4}}$	.0052
Width of $P_{\overline{4}}$	.0031
Height of $P_{\overline{4}}$	.0027

SPECIMEN 66.

Distance between mental foramina	.005
Length of last three premolars	.014
Length of $P_{\overline{2}}$	.0042
Width of $P_{\overline{2}}$	.002
Length of $P_{\overline{3}}$	.005
Width of $P_{\overline{3}}$	.0029
Length of $P_{\overline{4}}$	.005
Width of $P_{\overline{4}}$	.0037
Length of $M_{\overline{1}}$	.005
Width of $M_{\overline{1}}$ anterior	.0036
Width of $M_{\overline{1}}$ posterior	.0042
Height of crown of $M_{\overline{1}}$	.0024

Limnenetes, gen. nov.

The skull (No. 49) which I take as the type of this genus was found on a side hill about three miles northwest of Three Forks. It was near vertebræ of a small *Titanotherium*. The skull most nearly resembles *Oreodon gracilis* in size, yet it differs more or less from that species in most respects. The most striking characteristics are the following:

Skull low; frontal plane nearly flat; orbits open behind and as high as possible without arching of the frontal plane; a separate interparietal; tympanic bullæ large and longitudinally elliptical; basioccipital sharply angulate; zygomatic arches nearly parallel; sagittal crest low.

This skull belonged to an old animal and the teeth are so worn that their structure cannot be made out. There are other skull fragments with good teeth which were found in the same beds a couple of miles away. There are some differences, but I provisionally refer them to the same genus and describe part of them under the name of *P. anceps.*

Limnenetes platyceps, sp. nov. (Plate IX, Figs. 5 and 6.)

No. 49.

This is the skull on which the genus *Limnenetes* is founded.

Though the teeth are much worn it can be seen that the last two premolars are small. $P^{\underline{3}}$ is triangular, and $P^{\underline{4}}$ very short antero-posteriorly. The skull expands rapidly just anterior to the orbits and continues nearly the same width to the post-glenoid processes, giving this portion a rectangular aspect as seen from above. The anterior part of the nose is gone, so that only the posterior parts of the nasals are preserved.

The naso-frontal suture is short. From the naso-maxillary suture it extends backward and slightly inward, then nearly transversely to the median line, not forming a wedge. The nasals are narrow—not so wide as in *Oreodon gracilis.* They are flat on top as far as seen. The anterior lachrymal suture is nearly a semicircle. The lachrymal pit is shallow, and, with the orbital border just behind, is rugose. The supraorbital foramina are small and open a little less than one-third the distance from the frontal suture to the supraorbital border. The channels from these sweep forward and slightly inward, then outward and downward over the face, then backward to the infraorbital foramina which open above $P^{\underline{4}}$.

The frontals, though nearly flat, are slightly concave between the orbits with a low convexity along the frontal suture. Between the channels from the supraorbital foramina the surface is flat, but outside these convex.

The orbits are much larger than in *Oreodon gracilis.* They are circular and their upper borders lack only the thickness of the frontals above of being as high as the frontal plane—in fact they are about on a level with the slightly depressed median part of the frontal region. There are postorbital processes to the frontals and jugals, but they do not nearly meet, but end in points about 5 mm. apart.

The temporal ridges, beginning on the postorbital processes of the frontals, converge rapidly, then with a gentle backward curve meet about in the plane of the anterior borders of the glenoid surfaces. The parieto-temporal sutures follow these ridges for a little distance, then converging more rapidly form a wider angle in front of the stephanion. The sagittal crest is low, being highest just back of where the temporal ridges unite. Back of this it descends and becomes very low in front of the inion. A narrow median groove can be seen nearly the whole length. The inion is low—a little three-cornered area much lower than the frontal plane. Measuring from a line in the plane of the palate, it does not extend farther posteriorly than the occipital just above the foramen magnum.

The brain-case is full and well rounded out. It is broadest midway between the

middle transverse plane of the orbits, and the inion. Inward and backward from this are two convexities, one on each side of the higher part of the sagittal crest. The parieto-temporal suture makes a sigmoid curve upward and backward over the greater convexity of the brain-case and then extends backward parallel with the sagittal crest.

The interparietal is perfectly distinct from the other bones, having a well-defined suture all around. It is an equilateral triangle. The anterior angle is wedged in between the narrow, forked posterior processes of the parietals. It does not extend quite back to the posterior part of the skull, a narrow border of the supraoccipital intervening. The lambdoid ridges are low, not extending into wings.

The supraoccipital is nearly as broad as high. It is more nearly flat than in *Oreodon culbertsoni* or *O. gracilis.* Above it is slightly concave, with a hint of a median ridge. Below it is broadly convex and almost flat above the foramen magnum.

The basioccipital is narrow and sharply angulate below, the angular portion being in the same plane as the palate.

The tympanic bullæ are near together, large, high, evenly rounded, elliptical in outline, as seen from below, with the longer axis antero-posterior ; and they project downward farther than any other elements of the skull.* They are proportionally larger than in *Eporeodon* (Princeton Col., No. 10586). The external auditory meatus is trumpet-shaped like that of *Oreodon culbertsoni*, and it fills the space between the exoccipital and the post-glenoid process. The foramen ovale is above the anterior portion of the tympanic bulla. The foramen rotundum is small and just outside the posterior beginning of the pterygoids.

The posterior nares open between the anterior lobes of the last molars. The posterior median portions of the palatines end in a blunt point. The palate is concave in a transverse line and narrow. The posterior palatine foramina are between the interval between the last premolars and first molars.

The glenoid surface is somewhat convex antero-posteriorly, about the same as in *Oreodon culbertsoni.* The post-glenoid processes are broad transversely, bounding the whole glenoid surface posteriorly and extending outward nearly as far as the maximum expansion of the zygomatic arches, which is just anterior to the glenoid surface.

As before stated, the skull is very nearly the size of that of *Oreodon gracilis.* Its likeness to that seems more apparent on hasty examination than after detailed study. In many respects, as in the flatness of the top of the skull, the large size and superior position of the orbits, the shape of the brain-case and the size and form of the tympanic bullæ, it more resembles *Eporeodon* (?). In a specimen of this genus (Princeton Coll., No. 10568) which I have used for comparison, the postorbital processes of the frontal and

* Probably the paroccipital processes extended lower, but they are broken off.

jugal are but barely united, so that the present specimen comes nearer to *Eporeodon* (?) in this respect.

The beds from which this fossil was obtained are undoubtedly older than the Oreodon beds of South Dakota and very likely correspond to the lower Titanotherium beds; yet it is very doubtful whether this form is directly ancestral to *Oreodon culbertsoni* or *O. gracilis*, though I should say that it is more closely related to the latter. It is more probable that it is ancestral to *Eporeodon*, and that at least the forms with excessively large bullæ form a separate line from the Unita. But it is difficult to make comparisons or draw conclusions on account of the chaotic condition of this family. It probably will remain so until some one who can do it properly can have the opportunity of studying the vast amount of material that has been collected and who will undertake the enormous task of "straightening things out." There are about twenty species belonging to this family that have been found only in Montana.

Measurements.

	M.
Length of skull from anterior of P^3 to posterior of occipital condyle	.085
Length from back of M^3 to back of same	.049
Width of skull at fourth premolars.	.030
Width of skull at third molars	.062
Width of skull just anterior to glenoid surfaces	.065
Height of skull at fourth premolars	.025
Height of skull at centre of orbits	.030
Height of skull at occiput	.033
Width of skull between middle of orbits	.037
Width of brain-case	.0895
Diameter of orbits, antero-posterior	.020
Diameter of orbits, vertical	.020
Length of P^3	.0055
Width of P^3	.0055
Length of P^4	.005
Width of P^4	.0077
Length of M^1	.008
Width of M^1	.010
Length of M^2	.010
Width of M^2	.011
Length of M^3	.011
Width of M^3	.012

Limnenetes (?) *anceps*, sp. nov.

About two miles from where I found the type skull of *L. platyceps* I found several fragments of skulls and mandibles of *Oreodontidæ*. They were found in the same spot, but belong to at least five different individuals. One was a small *Agriochærus*, *A. minimus*, which will be described in this paper. In the same place were toe bones and part

of the femur of a rhinoceros, probably a small *Cœnapus*. A little distance away were remains of a *Titanotherium*. A mile or two farther north were quite a number of *Titanotherium* bones and there I obtained large portions of two skeletons.

The specimen which I take as the type of this species is the greater part of the anterior portion of a cranium (No. 50). Part of the snout and right maxillary are gone, but the root of the canine on the right side and the last two premolars and all the molars on the left side are preserved. It is only a little smaller than *Oreodon gracilis*.

Compared with *L. platyceps*, the frontal plane is still more flat but narrower; the lachrymal depressions are larger, deeper and different in shape; the infraorbital foramen is farther forward, being above $P^{\underline{3}}$ instead of $P^{\underline{4}}$; the nasals are different in shape and extend farther back.

The nasals are narrow, but broadest between the slender tips of the frontals. From here they narrow anteriorly to where they are broken off, and posteriorly to where they end in two small tips separated by a small wedge of the frontals. The latter, of course, may be only an individual character. This posterior extension of the nasals with the narrowness of the top of the skull make the anterior projections of the frontals rather long and narrow, and they end in slender tips which are wedged in between the nasals and the maxillaries. The lachrymals are larger than in *L. platyceps*, are not so nearly semicircular and they send up a peninsula of bone toward the nasals. The lachrymal depressions are deep and longitudinally elliptical. The teeth are so much like those of *Oreodon gracilis* as not to need a separate description. Compared with the specimen (Princeton Col., No. 11396) which I have used for comparison, $P^{\underline{2}}$ is a little more triangular and the median and anterior outer horns of the crescents are less prominent. One of the supraorbital foramina is farther back than the other, and shallow channels can be traced to the infraorbital foramina as in *L. platyceps*.

Among the other fragments is part of a skull (No. 52) that appears to be different from either of the preceding, but it belongs to a young animal. A small part of the postorbital process of the frontal is gone, but it was undoubtedly short and the orbit open behind.

There is also a series of milk teeth (No. 51), but not enough of the skull to determine the species.

Measurements of type specimen.

	M.
Length of dental series, exclusive of incisors	.054
Length of molar series	.028
Length of canine	.005
Width of canine	.0045
Length of $P^{\underline{3}}$	.006
Width of $P^{\underline{3}}$	.0065

	M.
Length of P^4	.006
Width of P^4	.008
Length of M^1	.008
Width of M^1	.010
Length of M^2	.010
Width of M^2	.012
Length of M^3	.0095
Width of M^3	.0125
Width of nasals, greatest	.0112
Width of skull between anterior of orbits	.030
Diameter of lachrymal depressions, antero-posterior	.013

Oreodon robustum, sp. nov.

Type No. 56.

The greater part of a skull found in bed of soft sandy clay, northeast of Toston, near the Missouri river, southeast of Helena.

It is readily distinguished from other species by several characters.

Distinguishing characters: *Size large; face and anterior nares deep vertically; nasals broad; zygomatic arch broad below orbits; palate broad; foramen ovale extremely large; tympanic bullæ very small and separated from basioccipital by a wide space; incisive foramina broad oval.*

The canines agree with the general robustness of the skull in being large. The crowns are not preserved. P^1 is narrow. P^2 is a little different from that of *O. culbertsoni*. It is narrower. The anterior festoons are smaller, there being two little pits, but the ridge or partition that divides them does not continue downward on the tooth. On account of the thinness of the principal cusp the posterior internal festoon encloses a larger area.

On the premaxillaries, beside the narial openings, are quite large depressions, which in their centres expose a small surface of the anterior roots of the canines. It looks as though the premaxillaries had begun to coössify. The height of the anterior nares and of the face are very marked. The nasals are broadest above the anterior parts of the lachrymal depressions. From here they are narrowed backward very regularly, ending in points. Their posterior portions form a convexity. The supraorbital foramina are farther apart than in *O. culbertsoni*.

The roof of the brain-case is broken away, showing part of the cast of the cerebrum and cerebellum.

The tympanic bullæ are similar to those of *O. culbertsoni* in form. The posterior portion, which abuts against the paroccipital, forms a process which extends downward a short distance in close contact with this larger process. Another process extends down-

ward opposite the post-glenoid. It is thin and antero-posteriorly compressed. A hint of it is seen in *O. culbertsoni* (Princeton Col., No. 10062). Another process extends backward and outward near the postero-interior face of the post-glenoid. A much larger space is left between the tympanic and the basioccipital than in *O. culbertsoni.* The ridge or convexity that bounds the inner side of the glenoid surface is much more prominent than in that species. The basioccipital is broader.

Measurements.

	M.
Length of skull from front of canine to back of paroccipital process	.192
Height of skull above P^{1}	.060
Height of skull above M^{1}	.064
Width of skull at canines	.055
Width of skull at anterior of orbits	.104
Height of narial opening over P^{1}	.040
Width of narial opening over P^{1}	.030
Width of molar under middle of orbit	.022
Width of palate between canines	.039
Width of palate between second premolars	.040
Width of palate between last molars	.037
Width of incisive foramina	.0095
Length of incisive foramina	.012
Length of foramen ovale	.009
Width of foramen ovale	.005
Length of molar-premolar series	.090
Length of premolar series	.045
Length of molar series	.045
Width of P^{1}	.006
Width of P^{2}	.0085
Width of both nasals, greatest	.030

Eucrotaphus helenæ, sp. nov.

Type No. 57.

The skull with the lower jaw. The anterior part of the skull and mandible, the occipital crest and zygomatic arches are gone. It was found northeast of Toston, in a bed of clay which contained nodular layers.

It was a young individual but nearly full grown, judging by the sutures of the skull. It has its temporary premolars. All the molars are fully erupted, but the last molars are unworn.

The nasals are quite broad above the third premolars. They narrow gradually and uniformly backward, ending in points in a plane with the anterior of the orbits. They are convex. The lachrymal pits are nearly circular and quite deep. The anterior prolongations of the frontals terminate in a plane with the fourth premolars. The lachrymal

is very large. The supraorbital foramina are farther apart than in *Oreodon culbertsoni*. The orbit is circular. The forehead is convex between the orbits, but concave in front of the stephanion. The brain-case is broad, full, and well rounded out. There are no distinct ridges near the parieto-temporal sutures. The anterior part of the sagittal crest is low. The brain-case here is full and arched upward. Back of this the crest is broken away, but evidently it was not high and narrow, as in *Oreodon culbertsoni* or the so-called *Eporeodon* of the White River or John Day. It appears to have been more like that of *O. gracilis*. The foramen magnum is large. The basioccipital in front of the condyles is broadly convex, then for a short space forms a rounded (not a sharp) angle, then is broadly convex again between the tympanic bullæ. The bullæ are large, but not so large as in *Eporeodon* (?) *major*. They are quite evenly rounded and longer antero-posteriorly than transversely. Posteriorly they abut against the paroccipital processes, which extend backward and outward. These processes are convex postero-internally and deeply concave antero-externally toward the bases. The post-glenoid processes are moderately thick. The posterior nares open between the posterior parts of the last molars.

The horizontal rami of the mandible are widely separated just behind the symphysis as in *Eporeodon*, but the caniniform premolars are very much nearer together and are nearly circular in section. The angle descends below the horizontal ramus. The coronoid process is narrow at its base and the condyle is a short distance behind it, making the sigmoid notch and the upper part of the mandible narrow antero-posteriorly as compared with *Eporeodon* (Princeton Col., 10586). The upper molars have very prominent outer horns to the crescents.

This animal resembles both *Oreodon gracilis* and *Eporeodon*, which perhaps form a different line from that of *O. culbertsoni*, but the latter is so variable and the validity of *Eporeodon* is so doubtful that I will not attempt the task of making comparisons. Even if *Eporeodon* is a valid genus this animal is quite different, and I prefer to use the older name *Eucrotaphus*.

Found in Toston beds in Broadwater county.

Measurements.

	M.
Length of skull from anterior of P^2 to posterior of occipital condyles	.158
Length from back of last molar to back of condyles	.080
Width of skull at middle of orbits	.104
Width of postorbital constriction	.035
Width of brain-case, greatest	.055
Width of condyles	.038
Width of foramen magnum	.021
Width of palate at last molars	.040
Length of paroccipital processes	.027

	M.
Length of bullæ, antero-posterior	.021
Width of bullæ	.016
Length of last three temporary premolars	.033
Length of molar series	.047

Agriochœrus maximus, sp. nov. (Plate IX, Fig. 4.)

Type No. 58.

Of this animal there is a right molar-premolar series and the last two premolars and the first two molars of the left side, with some small skull fragments. They were found on the Little Pipestone, southwestward from Whitehall. These teeth do not look like those of *Agriochœrus*, principally on account of their lowness and plain, flat appearance; yet when they are compared one by one with those of *Agriochœrus*, one does not feel warranted in establishing a new genus on these alone; though if a skull and skeleton were found, I have little doubt that the animal might prove to be a different thing.

Distinguishing characters: *Size large; teeth plain; the cheek teeth low, except* $P^{\underline{1}}$, *made up of crescents which are approximately low three-sided pyramids with broad bases.*

$P^{\underline{1}}$ subconical, longer than wide, with an anterior angle and a posterior depression; two-rooted. $P^{\underline{2}}$ simple, pyramidal; the outer side convex; the antero-inner nearly flat; postero-inner side concave, with a weak cingulum. $P^{\underline{3}}$ three-rooted, with a small deuterocone. The two inner sides equal. There is an incipient tendency toward the division of the outer crescent, as seen in the slight inner groove just behind the inner angle and the apex of the protocone. $P^{\underline{4}}$ has the same length as $P^{\underline{2}}$ and $P^{\underline{3}}$ but is broader. The two outer crescents are not separated down as far as in the molars. The deuterocone is as large, though not as high, as the outer crescents. It is subconical or subtriangular in section. There is a trace of a tritocone which looks like a cingulum. There is a faint cingulum nearer to the root.

$M^{\underline{1}}$ has short, broad, low crescents, with broad open valleys between. $M^{\underline{2}}$ and $M^{\underline{3}}$ are the same but longer antero-posteriorly. The animal was not old, as $M^{\underline{3}}$ had been recently erupted.

A small portion of the top of the skull shows the angle where the temporal ridges unite to form the sagittal crest. In the angle is a broad concavity and the ridges are broad and prominent. There is no deep groove at the angle. The anterior part of the sagittal crest is a low, broad convex ridge.

Measurements.

	M.
Length of molar-premolar series about*	.124
Length of premolar series	.052

* The posterior half of $M^{\underline{3}}$ is injured, and it is reckoned as the same length as the anterior part.

	M.
Length of molar series about*	.070
Length of P^1	.0105
Width of P^1	006
Height of crown of P^1	.009
Length of P^2	.015
Width of P^2	.0103
Height of crown of P^2	.0095
Length of P^3	.015
Width of P^3	.014
Height of P^3	.0105
Length of P^4	.015
Width of P^4	.017
Length of M^1	.019
Width of M^1	.022
Length of M^2	.0245
Width of M^2	.027
Height of M^2	.008
Width of M^3	.030

Agriochœrus minimus, sp. nov.

Type No. 59.

As *A. maximus* is the largest known *Agriochœrus*, if it is an *Agriochœrus* at all, so this species is the smallest. It is represented by the molars, last two premolars, and the zygomatic arch of the right side belonging to a mature individual. It was found in the White River beds, northwest of Three Forks, with *Limnenetes anceps*.

Specific characters: *Size small; P^3 long antero-posteriorly; outer crescents of molars very low, their outer faces looking downward much more than outward.*

P^3 as seen from above is nearly a right-angled triangle, with the right angle placed postero-externally. The outer surface of the protocone is concave with a faint ridge in the median line of the tooth. The tritocone is distinguished from the protocone as viewed from the inside, though it is not so apparent from the outside; but the protocone is the larger, the groove being behind the apex. The deuterocone is well developed and is opposite the tritocone. A ridge extends from its apex and along the inner side of the protocone to the anterior angle of the tooth. There are traces of a cingulum in the anterior and posterior faces of the deuterocone, and at the posterior outer base a small hint of a tetartocone.

P^4 is nearly an equilateral triangle in cross section with a rounded interior angle, as the deuterocone is conical. The separation of the protocone and tritocone has progressed farther than in P^3; the two are more nearly equal. This is apparent from

*The posterior half of M^3 is injured, and it is reckoned as the same length as the anterior part.

the outside in the truncation of the apex of the tooth. A protoloph begins at the apex of the deuterocone, and, becoming narrower and lower, extends to the outer anterior buttress. The tetartocone is small but well defined. A cingulum surrounds the inner part of the tooth.

The molars are broader than long. They bear very low crescents. The antero-external buttresses are large, especially on M^3. There are inner cingula on M^2 and M^3 and faint traces on M^1.

The zygomatic arch is quite broad under the orbit; its lower angle being opposite the posterior part of M^2. The anterior inferior root expands outward abruptly. One root of M^3 projects through the maxillary into the orbital plane. Evidently the posterior of the orbit was in the same plane as the posterior of the last molar.

Measurements.

	M.
Length of last two premolars and molars	.0400
Length of molar series	.0250
Length of P^3	.0075
Width of P^3	.0062
Height of crown of P^3	.0047
Length of P^4	.007
Width of P^4	.0084
Height of P^4	.0042
Length of M^1	.0085
Width of M^1	.009
Length of M^2	.0088
Width of M^2	.0105
Height of M^2 and M^3, each	.003
Length of M^3	.0103
Width of M^3	.012
Greatest width of zygomatic arch under orbit	.013

Arretotherium acridens, gen. et sp. nov. (Plate IX, Figs. 1-3.)

Type No. 60.

Of this unique animal I have most of the superior dentition and parts of the skull and skeleton. It was found in a fine sandy clay near Blacktail Deer creek, twenty-five miles south and east of Dillon, in the southwestern part of the State. Part of the posterior portion of a skull of a rhinoceros—probably *Cœnopus*—about the size of *C. tridactylum*, was found in a sandy layer near, and a considerable distance above the type of *Steneofiber hesperus* was obtained. The bones are much broken and part of them had been washed out and mixed in confusion in the clay. I saved all the fragments I could find, taking some of the material to the creek and "panning it out."

Part of the humerus of a cat, besides fragments of bones of one or two other animals, are mixed with those of this specimen, so it is sometimes difficult to be sure just what ones belong with it.

The teeth are different from those of any known animal. Those of *Hyopotamus* resemble them, especially the molars; but those of the present genus have no anterior intermediate "fifth" or "unpaired lobe," the protoconule. In this respect they are like *Merycopotamus.*

With the material in hand the principal characters seem to be the following:

All the upper teeth with sharp cusps or crescents; first premolar small; premolars increasing rapidly in size posteriorly, and composed of a simple compressed cone and a cingulum or cingulum-like cusp, which also increases in size backward; molars high, square in section, their length and breadth being nearly equal; occiput low; tarsus in the main resembling that of Oreodon.

DENTITION.

The only incisor preserved resembles the third of *Hyopotamus,* but it is much smaller and proportionally much thinner. The outside of the crown is uniformly convex. The inner side has a low, broad median convexity, so that, though thin, the tooth is thickest a little behind the middle and the edges are very thin. The anterior edge projects a little beyond the root.

Parts of two canines were found, the upper part of one and the lower part of the other. They were supposed to belong with the other teeth, as they were found closely associated with them. They are thin and sharp for an artiodactyl, yet not altogether exceptional, and they are quite sharp and finely serrate on the posterior edge. These characters, and the fact that part of a humerus of a cat was found with the other bones, makes it doubtful to what animal these canines belong. But when one sees the compressed character of the incisor and premolars and the sharpness of the apices of the molar crescents, it does not seem improbable that the canines belong to the present animal. The teeth are not more compressed than in *Moschus,* and not so long as in that genus or *Cervulus.* The serrated edge is not entirely exceptional, as Marsh has observed it in *Elomeryx armatus* (1894, p. 178, Fig. 3). The form of the tooth is not very closely like that of any cat I have seen. The whole length of the anterior edge of the crown is worn by contact with the lower canine. This, I think, does not occur in any of the cat tribe, as, at most, on account of the inner position of the lower canines and their obliqueness, only the base of the anterior part of the corresponding upper tooth could be worn by contact. The relative position of these teeth was evidently similar to that in the Peccary.

The canine is narrow laterally, more nearly flat on the inner surface and divided into three convexities by two faint longitudinal furrows. The outer surface is more convex, divided in the same way, but the middle convexity is much greater. The tooth contracts uniformly anteriorly, exteriorly and posteriorly from the base upward, ending in a small, smooth, rounded point. The appearance of the enamel is like that on the rest of the teeth, in all of which the inner angles and sometimes the outer are smooth, the other inner surfaces less so; while on the outer surfaces the enamel is slightly crinkled. The height of the crown was about .035 m.

The first premolar is small, longer antero-posteriorly than the incisor, and is thin—the thickest part and the apex being slightly anterior to the middle. The forward slope of the edge from the apex is straight, but back of the apex it drops abruptly, then slopes backward and curves downward. The thin anterior part, as in the incisor, projects a little anteriorly to the root. There is a short cingulum on the posterior inner side, which continues as a faint ridge to the anterior edge of the tooth.

Premolar 2 is longer antero-posteriorly and much higher, having a high, narrow apex, which is nearly central. From this apex the edges descend, vertically anteriorly and nearly so posteriorly for a short distance, and then both slope away, though not with exact symmetry, to the anterior and posterior edges of the tooth at the base of the crown. The outer convexity is not straight vertically. Beginning at the apex it extends downward a short distance, and then curves forward. The inner convexity is straight and median. There is an outer cingulum. The inner cingulum begins at the anterior angle of the tooth, but the posterior part is broken away.

The third premolar is nearly an enlarged copy of P^2. It is larger in every way. The main cusp is rather narrow, but the enlargement and expansion of the cingulum on the posterior inner part of the tooth gives the base a triangular form, with the posterior inner angle rounded. The cingulum encloses a large concavity or an oblong cup-like depression. A second premolar of a young *Hyopotamus* in the Princeton Collection (No. 10652) resembles this tooth.

P^4 has an outer and an inner crescent, the outer being the larger, longer and higher. There is an anterior and a posterior outer buttress at the outer angles. Both the anterior and posterior cingula are large and enclose furrows between them and the crescents. The outer crescent is concave externally with a median convexity. This is also true of the inner crescent. The posterior faces of the crescents are in the same plane. The anterior horn of the internal crescent is convex on the anterior face, and abuts against a small but comparatively high conical cusp or style which partly interrupts the valley between the two crescents.

As before stated, the molars have four crescents with no fifth lobe, and the length and width are nearly equal. As nearly as I can judge from the illustrations of Falconer and Cantley (1847, Part VII, Pl. LXII, Figs. 15 and 17), the last two molars are considerably like those of *Merycopotamus dissimilis*, but here the close similarity apparently ends.

Molar 1 is so much worn that little can be said of it, except that it is much smaller than $M^{\underline{2}}$ and is square in section. The anterior and posterior worn surfaces are confluent medially, and only the last narrow traces of the transverse valley are preserved, one as an external, the other as an internal projection, not quite meeting on the middle transverse line.

In the third and fourth molars the inner crescents embrace the inner bases of the external crescents, so that the median transverse valleys are much deeper than the median longitudinal ones. There are buttresses on the external horns of the external crescents; but the two median ones do not conjoin, forming a large one which cuts off the external entrance to the median transverse valley as in *Hyopotamus*. Owing to this and to the depth of the median valleys, the anterior and posterior halves of the teeth seem much more separated from each other than in that genus; in fact the last molar, especially, is almost cut in two. From the inner faces of the anterior inner crescents a short but thick cingulum extends backward and slightly outward, abutting against the anterior face of the posterior inner crescent. The anterior and posterior cingula are strong, and the depressions or valleys which they enclose are divided by the horns of the inner crescents. In the last molar the anterior horn of the posterior inner crescent continues to the anterior outer crescent, thus dividing the bottom of the transverse valley by a thin partition. The anterior roots of $M^{\underline{2}}$ are connate, thus forming one broad root. This probably is true of others, but they are not enough exposed to make it certain.

Three molars on one side and the last two on the other have part of the jaws attached. The incisor, canines and premolars were found separate. There are many fragments of molar teeth of the same kind, so there must have been more than one individual.

A fragment of a mandible is present which has one imperfect tooth. It is doubtful if this belongs to the same animal as the upper teeth. It looks more like the tooth of some member of the *Pecora* than we would expect to see in this animal. It is prismatic and quite high. In section each half of the tooth is a three-sided prism, the outer crescents being V-shaped at the top, but the outer angle becomes rounded below. On one of the outer crescents or plates there is a ridge that is not exactly median, as it begins below at the base of the posterior buttress, passes diagonally upward and forward, terminating in front of the apex of the crescent. This is probably $M_{\overline{2}}$.

The Skull.—A portion of the base of the skull is preserved, including part of the occiput, the occipital condyles, the basioccipital, the exoccipitals and small portions of the squamosals.

The occiput was low as in *Hyopotamus*, which it much resembles in some respects. The occipital condyles and foramen magnum are large. Their lower articulating surfaces are nearly flat medially. They form only a slight angle with the part of the basioccipital anterior to them. Between the paroccipital processes the basioccipital is broad and moderately convex. Anterior to this it is broad and quite thin. There is a longitudinal groove on the under side on the median line on the portion between the tympanics.

The exoccipitals are similar to those of *Hyopotamus*. They are broad and thin above, convex transversely and concave vertically. They are peculiarly roughened, appearing as if they were made up of several coössified bony plates. The paroccipital processes are both broken off, but they are nearly equilateral triangles in section, nearly on a level with the inferior surfaces of the occipital condyles. They are directed slightly backward as in *Hyopotamus*. The exoccipitals are transversely convex posteriorly and concave—except at the top—anteriorly, but they send forward a high ridge or wing which rests against the tympanic internally. This latter bone is tightly wedged in between this process, the outer part of the basioccipital and the squamosal.

The external auditory meatus is small and extends inward horizontally just beneath the lambdoid crest. Aside from this the space between the exoccipital and squamosal is entirely filled with bone. The two processes, the paroccipital and post-glenoid, do not approach each other as in the American species of *Hyopotamus*. Apparently the arrangement here is more like that in the fragment of skull figured in Kowalevsky's paper on *Hyopotamus*, in Pl. XXXIX, Fig. 5 (1873). The tympanic fills the greater part of the space above referred to. There is a groove extending downward and forward which appears to be a line of bony union, so that the portion anterior to this line may be a triangular exposure of the periotic. The bullæ are not preserved, but portions of the petrous were found which show that this bone was very large. One fragment shows a cast of the cochlea. The first whorl is much larger and is broader than either of the others, which are almost equal in size of whorl, but the third is slightly thicker. The first whorl is .005 m. in diameter and its greatest thickness .0015 m.; third whorl .003 m. in diameter.

The Atlas and Axis.—Only parts of these two vertebræ are preserved. The atlas has an extremely large neural canal, but a considerable portion was occupied by the large, broad and thick odontoid process of the axis. The floor of the canal is convex fore-and-aft, with a median transverse ridge bounding anteriorly the articular surface for the odontoid process. The anterior cotyles, if not confluent below, are almost so and are not separated

by a groove. The lower surface of the atlas is nearly flat with a median anterior convexity, evidently terminated by a short spine or protuberance which has been broken off. The posterior cotyles for the axis are nearly flat, and, like the anterior ones, are almost confluent below.

The odontoid of the axis is broad and thick. As stated by Scott in the case of *Hyopotamus brachyrhyncus* (1895, p. 470), it is "neither conical nor spout-shaped, but intermediate between the two." It is broad and thick. A section at the base, also the anterior edge, are almost semicircles, so the process is approximately the sector of a sphere. The upper surface, however, is not flat, but somewhat irregular. Anteriorly it is beginning to be spout-shaped, but there is a broad median convexity. Farther back at the base is a greater prominence, terminating anteriorly in two V-shaped convexities, one on each side of the median line. With the exception of this prominence and its greater width, this process resembles that of *Agriochœrus*. The atlanteal surfaces of the axis are convex ventro-dorsally, and they slope backward more than in the last-named genus.

The Humerus.—The head is unusually flat on the articular surface, the convexity being mostly on the inner portion. The lower portion differs both from the one described by Scott as *Ancodus brachyrhyncus* and the one figured by Kowalevsky as *Diplopus* (1873, Pl. XXXVI, Fig. 4). The inner epicondyle is very uneven on the outer surface, being covered with irregular ridges and depressions. It is much thinner than in *Hyopotamus* and different in shape. Instead of being broad posteriorly to its lower extremity it has a narrow border. The trochlea is also different. The median ridge is almost as prominent as the inner one. The outer convexity is small and looks like an accessory ridge on the median one. The inner groove is deep and the ridges are not oblique.

The Tibia.—The distal end is compressed antero-posteriorly, its transverse being nearly twice its other diameter. The facets for the astragalus are very oblique, the inner one being narrower and deeper than the outer. The outer edge of the tibia is angulate to near the astragular facet, where there is a small oblique truncation. This evidently was not for the shaft of the fibula, as that lay in the broad convexity anterior and internal to the outer angle.

The Fibula.—The lower end of the fibula is laterally compressed. Its antero-posterior is twice its other diameter. There are on the outer side an anterior and a posterior ridge and a smaller one on the plane surface between. The facet for the calcaneum is oblong-oval or hastate, terminating posteriorly in a point. There is a posterior concave surface and a smaller anterior convex one. The facet for the astragalus is different from that of *Diplopus* (Kowalevsky, 1873, Pl. XXXV, Fig. 3), being more like that of

Oreodon. It is a lobe extending backward and upward and is broadly rounded at the extremity, not forming a half crescent as in *Diplopus.* It has no raised border or ridge projecting over the upper edge of the outer ridge of the proximal trochlea, as in the specimen No. 11162 of the Princeton Collection, the foot of which is figured in Scott's paper (1895, Pl. XXIV, Fig. 9). This articular surface occupies an elevated plane. The posterior side of this elevation is higher than the anterior.

The Tarsus.—The tuber of the calcaneum is most like that of *Oreodon,* but is much more robust in proportion to its length, especially so at the upper extremity. It is like that, too, in having no tuberosity or accessory facet on the sustentaculum, the inner border of which is a sharp angle all around.

The astragalus is longer in proportion to its width than in *Agriochœrus,* but much shorter than in *Hyopotamus* or even *Oreodon.* In other respects it differs little from that of *Oreodon.* The oblique ridge above the calcanear facet is not so prominent. As in *Oreodon,* there is a faint ridge defining the inner boundary of the facet for the calcaneum, but no massive ridge with an accessory facet as in *Hyopotamus* or *Agriochœrus.*

The cuboid is much like that of *Oreodon,* but the calcanear notch is very shallow, not descending so low as in that genus. In *Hyopotamus* it descends still lower. As seen from the front the notch occupies only one-third the width of the cuboid, and it apparently did not reach backward more than half the antero-posterior thickness of the bone. The cuboid is more regular in outline and much nearer a cube than in *Hyopotamus, Agriochœrus* and *Oreodon.*

The navicular is more like that of *Hyopotamus,* but there is no plantar hook. Behind the proximal articular surface there are two lobes, as a valley runs down the plantar side. The inner lobe is the larger, projecting backward, so that the inner length of the bone is greater than that in *Hyopotamus.* The distal surface is nearly a plane surface, with the exception of a small median inner convexity. The inner side is more regular than in *Hyopotamus.*

The ectocuneiform is nearly like that of *Oreodon.* There is a small facet for metacarpal II, which has two faces, one more concave than the other. Above this is a small triangular facet for the mesocuneiform. On the plantar side there is a wide groove or valley, passing obliquely downward and inward from the proximal to the distal surface.

The tarsus, as far as preserved, is characterized by its plainness and lack of complication. Unless the meso- and entocuneiforms were larger than common, there must have been a large median plantar space unoccupied by tarsal bones. We have not the proximal ends of the metacarpals, so it cannot be ascertained whether there were any posterior prolongations filling this space or not.

There are no complete metapodials. There are the proximal ends of one of the smaller ones and the distal ends of eight of various sizes. The proximal portion of the smaller metapodial, compared with the median ones, is larger proportionally than in the pes of *H. brachyrhyncus* (?) (Princeton Coll., 11162). The head is thick transversely, triangular in section, conical at the top and larger than the shaft. The shaft, a little below the head, is transversely oval. The distal ends of three of the median metapodials are much like those of *Hyopotamus,* but the dorsal surfaces of the trochlea are not so convex or the groove above so deep, and the trochlea are not bent in toward the plantar side as in *Oreodon* or *Agriochœrus.* The distal ends of two lateral metapodials are symmetrical. They are quite thick and do not appear to have been in close contact with the median ones. There was probably either a hallux or a pollex, as there are two distal ends of very small metapodials.

There are several portions of phalanges and two middle ones nearly complete. The latter are short. The proximal articulating surfaces are slightly concave and separated by a low median convexity. The distal facets have a shallow groove. A lateral ungual is asymmetrical. Its dorso-plantar is greater than its transverse diameter. It has approximately the form and size of one of the median ones of *Oreodon culbertsoni,* but it is shorter and the proximal facet is divided into two unequal areas. One of the median unguals is only a little thicker planto-dorsally, but much broader. The anterior part is gone, but so far as shown the inner margin is nearly straight, while the outer curves inward toward the tip.

Discussion of Relationship of Arretotherium.

Until more complete material of this animal is found, or that of related forms, it would be unwise to form a judgment as to its relationship. We can see resemblances, but these are far from being proof of relationship. There is enough preserved to show that it is very different from any other American genus at least. The skull, so far as preserved, is suggestively similar to that of *Hyopotamus.* The molars, too, aside from the absence of the protoconule, resemble those of *Hyopotamus.* They seem to be much like those of the Indian *Merycopotamus.* The premolars are different from those of *Hyopotamus.* The atlas is not much like anything I know. The lower end of the fibula, the calcaneum, astragalus and cuboid are similar to *Oreodon.* The navicular and the metacarpals and phalanges appear to be more like those of *Hyopotamus.* There is no evidence of relationship to *Agriochœrus.*

Measurements.

	M.
Length of molar-premolar series arranged, without diastema; left side	.130
Length of incisor (I^{3} ?)	.0074
Width of incisor (I^{3} ?)	.004

	M.
Height of incisor ($I^{\underline{3}}$?), crown	.006
Length of canine	.016
Width of canine	.009
Height of canine	.035
Length of $P^{\underline{1}}$	.0092
Width of $P^{\underline{1}}$	.004
Height of $P^{\underline{1}}$	.006
Length of $P^{\underline{2}}$	.0135
Width of $P^{\underline{2}}$, middle	.008
Height of $P^{\underline{2}}$	.011
Length of $P^{\underline{3}}$	017
Width of $P^{\underline{3}}$	.014
Width of $P^{\underline{3}}$, protocone	.0085
Height of $P^{\underline{3}}$	.013
Length of $P^{\underline{4}}$	.016
Width of $P^{\underline{4}}$	.020
Height of $P^{\underline{4}}$	.014
Length of molar series	.072
Length of $M^{\underline{1}}$	.0185
Width of $M^{\underline{1}}$	.020
Length of $M^{\underline{2}}$	.024
Width of $M^{\underline{2}}$	.0255
Length of $M^{\underline{3}}$	.0285
Width of $M^{\underline{3}}$	.0295
Height of $M^{\underline{3}}$	.0190
Length of $M^{\underline{2}}$, right side	.255
Width of $M^{\underline{2}}$, right side	.027
Length of $M^{\underline{3}}$, right side	.029
Width of $M^{\underline{3}}$, right side	.030
Width of foramen magnum, about	.026
Width of occipital condyles, about	.055
Width of neural canal of atlas	.030
Width of anterior cotyles of atlas	.057
Width of odontoid process of axis	.020
Thickness of odontoid process of axis at base	.012
Diameter of distal end of tibia, transverse	.0415
Diameter of distal end of tibia, dorso-plantar	.0235
Diameter of distal end of fibula, transverse	.0103
Diameter of distal end of fibula, dorso-plantar	.0207
Length of tuber of calcaneum above astragalar facet	.043
Diameter of tuber of calcaneum in middle, transverse	.0135
Diameter of tuber of calcaneum in middle, dorso-plantar	.023
Length of astragalus	.0435
Width of astragalus	.027
Thickness of astragalus, dorso-plantar	024
Length of cuboid, anterior	.020
Width of cuboid, transverse	.0212
Thickness of cuboid near top	.024

	M
Length of navicular	.021
Width of navicular	.022
Thickness of navicular, dorso-plantar	.0327
Length of ectocuneiform	.012
Width of ectocuneiform	.020
Thickness of ectocuneiform	.014
Width of a median metapodial just above trochlea	.018
Thickness of same	.015

EXPLANATION OF PLATE IX.

Figs. 1–3. *Arretotherium acridens*, gen. et sp. nov. Natural size. From Blacktail Deer creek.

Fig. 1. Upper teeth of right side. Outer view.

Fig. 2. The same, from below. In Figs. 1 and 2, premolars 3 and 4 are restored from left side. The position and arrangement of the antemolars is conjectural, as they were not found in place.

Fig. 3. Left tarsus with distal extremities of tibia and fibula. Navicular restored from right side.

Fig. 4. *Agriochœrus* (?) *maximus*, sp. nov. Natural size. Molar-premolar series from the right side. From Pipestone creek.

Figs. 5, 6. *Limnenetes platyceps*, gen. et sp. nov. Natural size. From Thompson creek, near Three Forks.

Fig. 7. *Bathegenys alpha*, gen. et sp. nov. Spec. No. 48. Anterior of left mandibular ramus. Natural size. Pipestone creek.

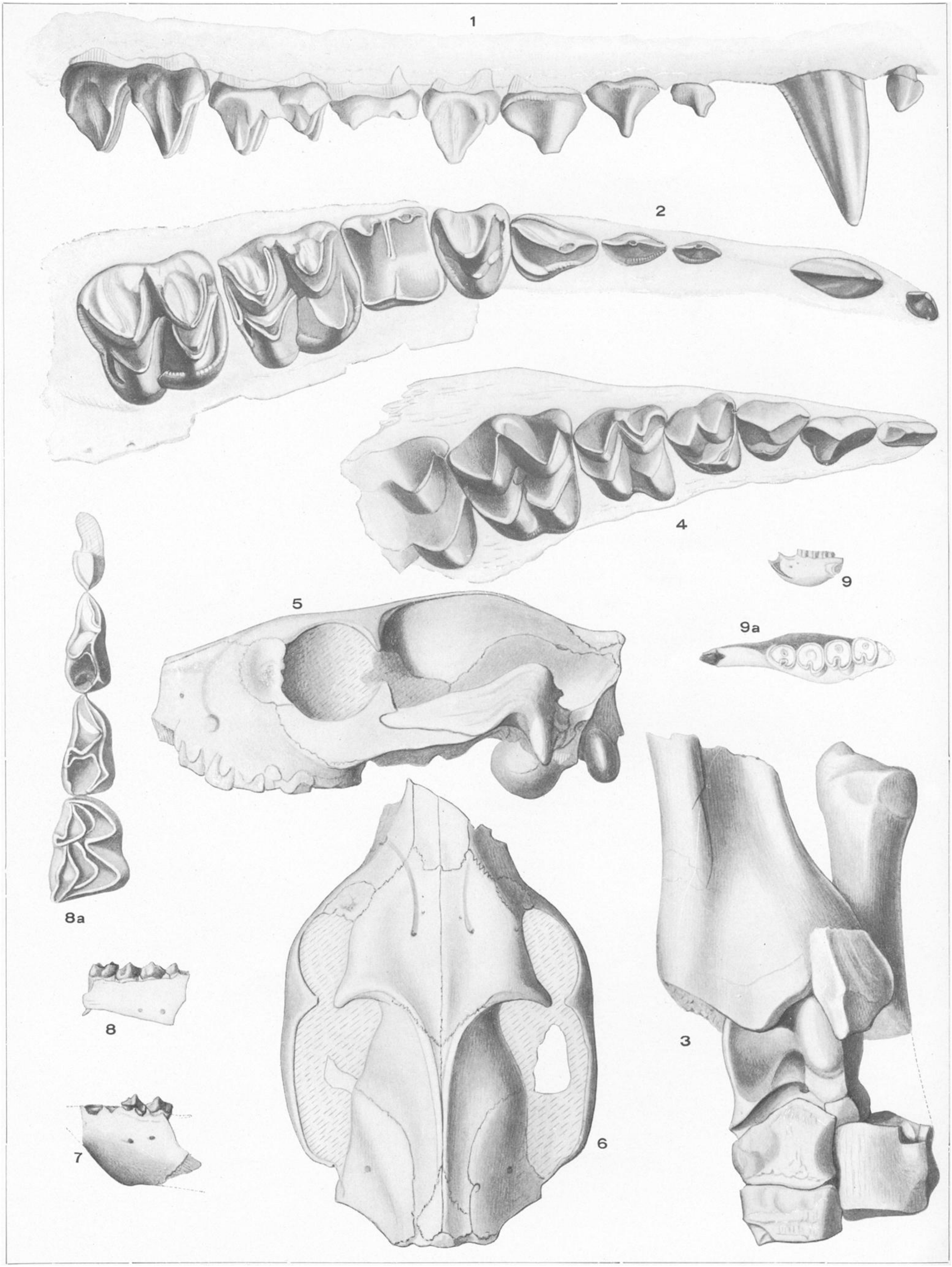
Fig. 8. *Bathygenys*. Spec. No. 66. Another individual and perhaps a different species from Fig. 7. The last three premolars and the first molar. Natural size.

Fig. 8a. The same, with teeth magnified four diameters.

Fig. 9. *Cylindrodon fontis*, gen. et sp. nov. Left mandibular ramus. Natural size. Pipestone creek.

Fig. 9a. The same. Enlarged three diameters.

For "Literature," etc., see page 279.



ARRETOTHERIUM, AGRIOCHŒRUS, LIMNENETES, BATHYGENYS AND CYLINDRODON.

Literature.

1877. Cope, E. D.: Extinct Vertebrata Found in New Mexico. U. S. Geol. Surv. W. of 100th Merid., Vol. IV, Part II.

1883, (1884.) —— Tertiary Vertebrata. Rep't U. S. Geol. and Geog. Survey of the Territories, Vol. III.

1899, (1900.) Douglass, E.: The Neocene Lake Beds of Western Montana. University of Montana.

1900. —— New Species of Merycochœrus in Montana. Amer. Journ. of Science, Dec., 1900.

1901. —— The same. Jan., 1901.

1847. Falconer, H., and Cautley, P. T.: Fauna Antiqua Sivalensis.

1891. Filhol, H.: Etudes Mammiferes Fossiles de St. Gerard le Puy.

1873, 1874. Kowalevsky, W.: On the Osteology of the Hyopotamida. Phil. Trans. of the Royal Soc. London, Vol. 163.

1869. Leidy, J.: Extinct Mam. Fauna of Dakota and Nebraska. Journ. Acad. Nat. Sci. Phila.

1894. Marsh, O. C.: Miocene Artiodactyla from the Eastern Eohippus Beds. Amer. Journ. Sciences, Aug., 1894.

1893. Scott, W. B.: The Mammalia of the Deep River Beds. Trans. Amer. Phil. Soc., New Series, Vol. XVII.

1895. —— The Structure and Relationships of Ancodus. Journ. Acad. Nat. Sci. Phila., Vol. IX, Part IV.

List of Species Described with the Specimen Number.

No. 36. *Ictops acutidens*, sp. nov.
No. 37. *Eumys minor*, sp. nov.
Nos. 38 and 39. *Cylindrodon fontis*, gen. et sp. nov.
No. 40. *Sciurus jeffersoni*, sp. nov.
No. 41. *Steneofiber hesperus*, sp. nov.
No. 42. *Steneofiber complexus*, sp. nov.
Nos. 43, 44 and 45. *Palæolagus temnodon*, sp. nov.
No. 46. *Hyænodon montanus*, sp. nov.
No. 47. *Hyænodon minutus*, sp. nov.
Nos. 48 and 66. *Bathygenys alpha*, gen. et sp. nov.
No. 49. *Limnenetes platyceps*, gen. et sp. nov.
No. 50. *Limnenetes* (?) *anceps*, sp. nov.
No. 56. *Oreodon robustum*, sp. nov.
No. 57. *Eucrotaphus helenæ*, sp. nov.
No. 58. *Agriochœrus maximus*, sp. nov.
No. 59. *Agriochœrus minimus*, sp. nov.
No. 60. *Arretotherium acutidens*, gen. et sp. nov.
No. 62. *Colodon cingulatus*, sp. nov.
No. 63. *Colodon*, sp.